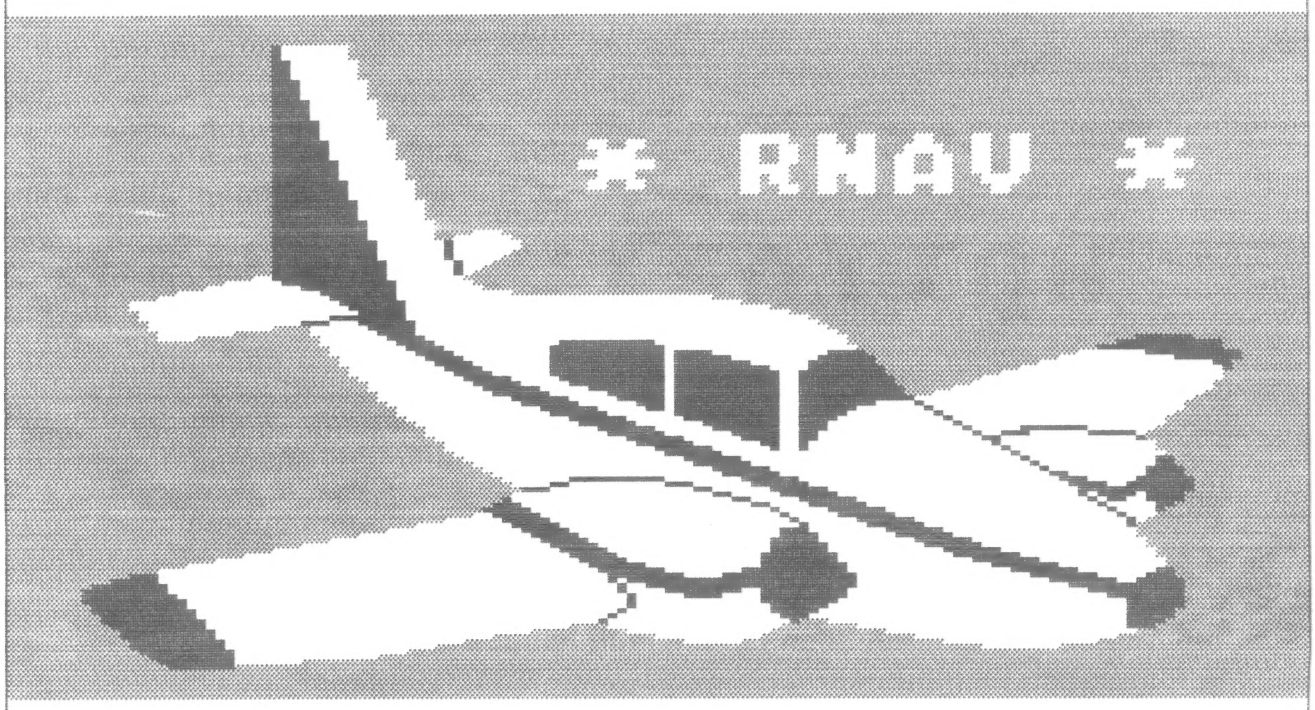
# AIR NAVIGATION

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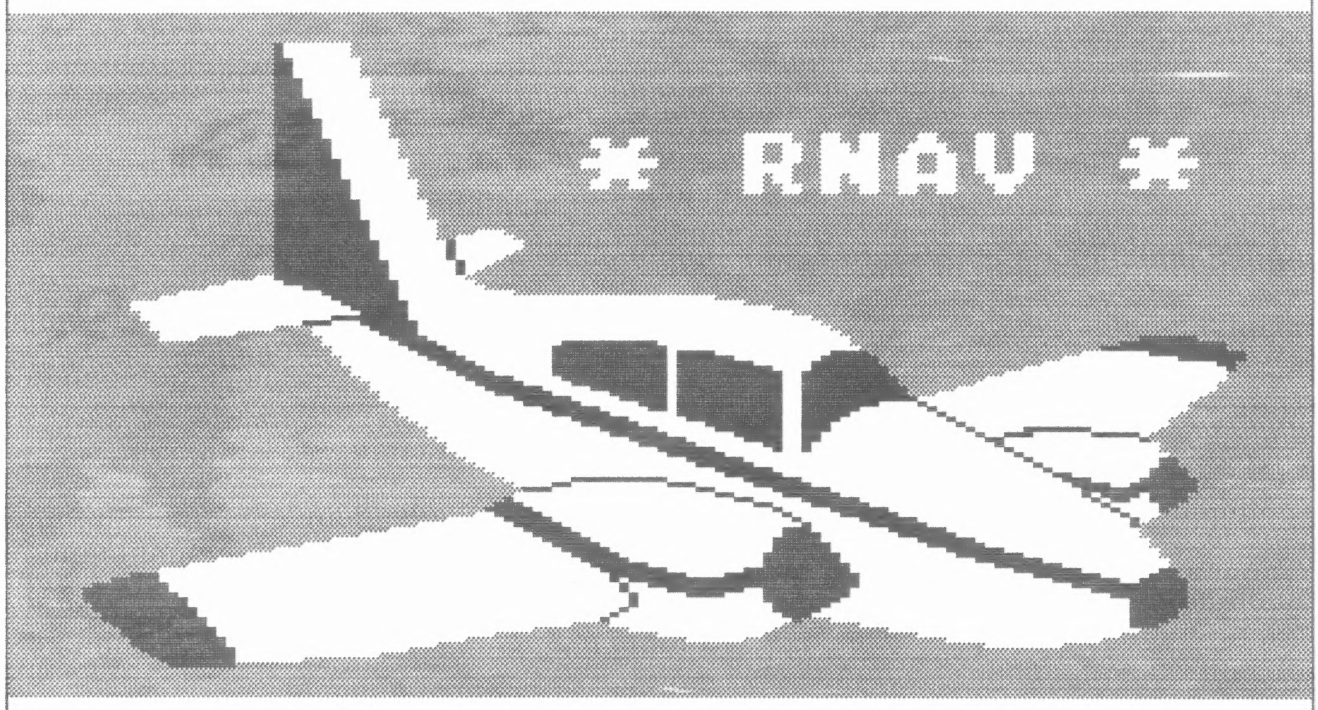
MANUAL

DOCUMENTATION

Revision 1-21-84

# AIR NAVIGATION

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PROGRAM MANUAL

# AIR NAVIGATION/*RNAV*

by

Robert A. Tims

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# AIR NAVIGATION/*RNAV*

## I. INTRODUCTION

### OVERVIEW

The objective of AIR NAVIGATION/*RNAV* is to help you more easily plan your flight routes. It will figure your magnetic course and distance from and to airports, navaids, intersections, and waypoints. Your waypoints will be calculated along your route using the navaids you choose. You will know your total distance, leg and remaining distance.

A special data diskette will be formatted by the program. The data diskette will be used to store your nav data and flight routes. After nav data has been stored on the data diskette, a backup copy should be made to prevent accidental loss of information. Section XI explains this process

The nav data file can remember up to 250 different airports and navaids and store them on the data diskette. The nav data can be easily entered, edited, deleted, viewed, and printed. You can store up to 26 of your most frequently traveled routes on the data diskette. The program will view the route on the screen or print it on paper for you; both forwards and backwards.

### REQUIRED ACCESSORIES

ATARI BASIC Language Cartridge
40K RAM
ATARI 810 Disk Drive

### OPTIONAL ACCESSORIES

ATARI Printer or equivalent printer
ATARI 850 Interface

### CONTACTING THE AUTHOR

Users wishing to contact the author about AIR NAVIGATION/*RNAV* may write or, preferably, call him at:

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Jonesboro, AR 72401
(501) 935-7586

## PREREQUISITES

As AIR NAVIGATION/*RNAV* is a flight route planning aid, a knowledge of aeronautical navigation is prerequisite to the utilization of the program. Every student pilot is exposed to sufficient navigation principles to understand the terms and concepts used in AIR NAVIGATION/*RNAV*.

Some new pilots may not have been exposed to RNAV (Area Navigation). Hopefully the examples in this manual will explain what RNAV is. If there are questions about aeronautical navigation, including RNAV, your local flight instructor should be consulted.

## II. GETTING STARTED

### LOADING AIR NAVIGATION/*RNAV

A. Insert the ATARI BASIC Language Cartridge in the (left) cartridge slot of your computer.

B. Have your computer turned OFF.

C. Turn on your disk drive.

D. When the BUSY light goes out, open the disk drive door and insert the AIR NAVIGATION/*RNAV* program diskette with the label in the lower right-hand corner nearest you. (Use disk drive 1 if you have more than one drive.)

E. Turn on your computer and your TV set. The program will load into computer memory and start automatically.

F. After you turn your computer system on, the title display will appear on the television after a few seconds. When the program diskette finishes loading, the following prompt will appear at the bottom of the display:

INSERT DATA DISK
PUSH ANY KEY

Remove the program diskette. Insert the data diskette and press any key. The data will then load, and the following message will be displayed:

LOADING DATA

### PREPARING THE DATA DISKETTE

If you haven't previously prepared a data diskette you will need to in order to continue with the program. At the above prompt, when asked to insert the data disk and push any key, leave the program diskette in the disk drive and press any key. The following question will be asked:

FORMAT DATA DISK Y/N

If you had accidently pushed a key before inserting the data diskette or if you had inserted the wrong disk, then push the [N] key to back up to the prompt for the data diskette.

If you are preparing a data diskette then push the [Y] key. The program will remind you to insert the program diskette:

INSERT PRGM DISK
PUSH ANY KEY

If the program diskette is not in the disk drive when a key is pressed the program will take you back to the prompt to insert the data diskette.

If the program diskette is in place the program for preparing the data diskette will be loaded and you will see the following message:

LOADING PRGM

When the program is loaded the first screen will be:

INSERT A DISK

INTO DRIVE 1

(FORMATTED OR BLANK)

* WARNING! *

THIS OPERATION
WILL ERASE ANY
DATA ON THE DISK

DO YOU WANT TO

FORMAT A DATA DISK

Y/N?

The diskette will be formatted as part of its preparation. This will erase any data that may have been on the diskette, unless the diskette is unnotched or has its write-protect notch covered with a write-protect label.

If you decide to abort the data disk preparation then push the [N] key. You will be prompted:

INSERT PRGM DISK
PUSH ANY KEY

Insert the program diskette into the disk drive and push any key. The AIR NAVIGATION/*RNAV* program will be reloaded.

To prepare a data diskette, insert the diskette you wish to use in the disk drive. It doesn't have to be formatted; but if it has been, do make sure there isn't any data on it that you want to keep. Press the [Y] key and the formatting process will begin with the following message displayed:

FORMATTING

After the formatting process is completed the necessary files will be created on the diskette. While this is taking place this message will be displayed:

WRITING FILES

After the files have been written succesfully the following prompt will be displayed:

MISSION ACCOMPLISHED
INSERT PRGM DISK
PUSH ANY KEY

Insert the program diskette, push any key, and the AIR NAVIGATION/*RNAV* program will be reloaded. If the program diskette is not in the disk drive, the program will take you back to the first screen. You then will have the choice to prepare another data diskette or go back to the AIR NAVIGATION/*RNAV* program.

If the diskette you are preparing has a bad sector on it the preparation process will be aborted and the program will say:

* DISK PROBLEM *
TO CONTINUE-
PUSH ANY KEY

By pressing any key you will go back to the first screen. You will have the choice of trying to prepare the same diskette, prepare a different diskette, or go back to the AIR NAVIGATION/*RNAV* program.

## COMMANDS

All commands are one key stroke. The [RETURN] key need not be used after a command. Most of the commands will be MENU responses and will use the keys [0] through [5]. The [0] key will always return you to the previous menu. The other commands will be a "Y/N" prompted response. The [Y] key for "Yes" and the [N] key for "No". All the command options are given in the current option menu or prompt that is being displayed. The exceptions are the two undisplayed options at the Main Menu, and the use of the [ESC] key to abort the printing of the nav data.

## ENTERING DATA

Whenever data is prompted for, a data line the length of the spaces allowed will be displayed after the prompt. Only the type of data requested will be accepted in order to help eliminate typo errors. The cursor is not used in nav data input, the data line is used instead. The function keys that remain active are the [BACK S] and [RETURN] keys.

Data input is terminated with the [RETURN] key. Data input may be declined by not entering any data and pressing the [RETURN] key. Declining input is an implied program command, and its effect on the program will be covered in each section where data is entered.

## DEGREE FORMAT

The first time you run the AIR NAVIGATION/*RNAV* program, and until nav data has been entered, the first screen you'll see after the title display will be the degree format options. This is the format used when entering the latitude and longitude coordinates. The degree, minute, and second format is used in the NOAA AIRPORT/FACILITY DIRECTORY. The degree, minute, and tenth of a minute format is used in the Jeppesen charts. In the AIR NAVIGATION/*RNAV* Program you have the choice of either one.

The LAT/LNG FORMAT menu will display the two options, how they should be entered, and examples.

```
ENTRIES: 0        FORMAT: DD° MM′ SS"
```

## LAT/LNG FORMAT

```
[0] RETURN TO MENU

[1] DEGREES, MINUTES, & SECONDS
    FORMAT:  DD° MM′ SS"
         Example: 90° 38′ 47"
    ENTRY FORM:  DD.MMSS
         Example:  90.3847

[2] DEGREES, MINUTES, & TENTHS
    FORMAT: DD° MM.d′
         Example: 90° 38.8′
    ENTRY FORM: DD.MMd
         Example: 90.388
```

The top line of the LAT/LNG FORMAT menu displays the number of entries in the nav data file. If you have entered this menu upon loading the program then the number of entries will be 0. You will need to decide which format you want to use. It is possible to change your choice later, and reformat any data stored, by using one of the edit options. The right side of the top line will show the current FORMAT option.

Whenever you attempt to go to the Main Menu with an empty nav data file, you'll always be routed to the LAT/LNG FORMAT Menu first. Using the [0] RETURN TO MENU option will take you to the Main Menu without changing the current Degree Format. If you have entered the LAT/LNG FORMAT Menu as an edit option, than the [0] option will take you back to the Edit Menu without changing the format.

When you first start using this program the default Degree Format is the [1] DEGREES, MINUTES, & SECONDS option. This format will be the default until you have chosen the [2] DEGREES, MINUTES, & TENTHS option and have made entries into the nav data file. When the program stores the nav data file on the data diskette it will also store the format choice you have made. From then on, whenever you use the program your format choice will be the default format until you change it.

The program will display the coordinates using the format form. Please note that you'll be entering it in the entry form as shown in the display example. We are used to seeing angles displayed with their proper symbols. Example:

78 Degrees, 8 minutes, and 28 seconds is written as 78° 06′ 28". However, it is much easier to enter it in as data by typing 78.0628.

## MAIN MENU

The Main Menu will have the same graphic display as the title page with the following choices:

[1] ROUTE ENTRY
[2] LOAD FLIGHT
[3] AIRNAV DATA

[1] ROUTE ENTRY will allow you to enter in the flight route you are planning. You will enter in your navigation fixes by their identifiers, starting with your departure point and sequencing to your destination. After your route is entered it will be displayed back for correctness. If it is what you want then you'll be given the options of the Navigation Menu.

The Navigation Menu is the heart of the program. It'll allow you to display, print, reverse, and save the route.

[2] LOAD FLIGHT will list the flight routes you've stored along with the empty routes yet to be used. When you choose one of the routes it will be displayed for you to confirm its the one you wanted. If it is, then you'll have the Navigation Menu options.

[3] AIRNAV DATA is the portion of the program which allows you to enter fix coordinates in the nav data file, edit, view, and print them.

[ESC] will allow you to exit the program. It will turn the control of the computer back to you and the ATARI BASIC Cartridge. Your computer will be reset and the READY prompt will appear. The [ESC] option (here at the Main Menu and when printing the nav data) and the next one ([P]) are the only "hidden" commands in the program. All other options are displayed.

[P] allows you to enter printer codes. Pressing the [P] key will display the printer codes for initializing the printer and for entering the code you'll need for the degree symbol. The codes will initially be nulls, heart symbols, and will have no effect on your printer. After you enter your codes for your printer, you'll be able to save them on the data diskette. This option is discussed in detail in section VII.

[BREAK] has no effect on the program. The [BREAK] key has been disabled so the program will not be accidently interrupted.

[SYSTEM RESET] will reboot your system. If the program disk is in your disk drive, then the program will be reloaded. If the data disk is in then the screen will display a "BOOT ERROR" message, unless the DOS files have been written on it. After the data diskette has been prepared the DOS files may be written on it by using item H (write DOS files) in the DOS menu. A good time to do this would be when you are making a backup copy of the data diskette as you would be in the DOS menu at that time. See Section XI on backup procedures.

## III. AIRNAV DATA

### INTRODUCTION

The program uses the Latitude and Longtitude coordinates to calculate the true course and distance between any two fixes. The magnetic course is obtained by adding the magnetic variation to the true course. The nav fixes should be identified by their National or ICAO location identifier.

The nav data file is used to store up to 250 fixes for your use. The identifier is all that is needed for the program to recall the coordinates once they are entered into the file.

Fixes are seperated into airports and navaids. The reason for this is that often a navaid will have the same three letter identifier as the nearby airport. U.S. airports have a four letter identifier. The first letter (K - identifier for U.S.) is omitted most of the time, leaving the three letter identifier we commonly use. Navaids are defined in the Pilot/Controller Glossary as any device "which provides point to point guidance information or position data to aircraft in flight." To most of us that means a VOR, VORTAC, TACAN, or NDB.

Location identifiers, coordinates, and magnetic variation can be obtained from the AIRPORT/FACILITY DIRECTORY, or a similiar service. Access to the Directory can be had at any FAA Flight Service Station if you don't have your own subscription. Your local airport would be another good source for the information.

### AIRNAV DATA MENU

The top line of the Airnav Data Menu will display the number of entries and the degree format. The second line (in large letters) is the menu title. Then the five options, using keys [0] - [4], are:

[0] - Return to the Main Menu.
[1] - Enter data for navaids.
[2] - Enter data for airports.
[3] - Edit data that has been entered.
[4] - View entered data singly or scrolled on the screen; or printed on paper.

Below is the Airnav Data Menu:

ENTRIES: 0 FORMAT: DD° MM′ SS"

AIRNAV DATA MENU

0 MENU

1 NAVAIDS

2 AIRPORTS

3 EDIT

4 VIEW

RETURNING TO THE MAIN MENU

The [0] key will return you to the Main Menu. If you have entered or edited any data the program will process it first. It will sort the nav data file by the three letter identifiers, with navaids being listed before airports. The file, including the format option, will then be stored on the data diskette. While the file is being stored the AIR NAVIGATION/*RNAV* graphics with the following announcement at the bottom will be displayed:

I AM STASHING
THE NAV DATA!

DATA ENTRY

By pressing the [1] key you'll be telling the computer the data you are entering will be a navaid. If you press the [2] key then the computer will know you are entering data for an airport. The top of the screen will show the present entry number and the coordinate degree format:

ENTRY: 1 FORMAT: DD° MM′ SS"

NAVAID DATA ENTRY

- OR -

ENTRY: 1 FORMAT: DD° MM′ SS"

AIRPORT DATA ENTRY

At the bottom of the screen, the following prompt will appear:

IDENTIFIER? ___

If the data is for a navaid the data input line will be 3 spaces long. An airport identifier data input line is 4 spaces long. This allows the full ICAO lacation identifier to be used for those who wish to retain the "K" for the international airports. If less than 4 characters is inputed the program will insert a blank space for the first character. This will allow a four letter identifier to properly line up with the three letter identifers. If you decline entry the program will return you to the Airnav Data Menu.

Anytime entry of too many characters is attempted on a data line, the tone will sound and the data reprompted.

Press [RETURN] after entering the identifier to let your computer know you are ready to continue. The identifier will be moved up on the screen and the Latitude prompt will appear at the screen bottom:

LATITUDE? _____

If the degree format is tenths of a minute instead of using seconds the data line will be 1 character shorter. The same will be true when the Longitude is prompted for.

If entry is declined the program will move back to the identifier prompt.

The data input must be between 0 and 90.0000 or it will be rejected. This program will not accept negative latitude or longitude. An explaination is given in section IX on Program Limitations. If the input for minutes or seconds is over 59 then it will be rejected. (i.e. An input of 89.3400 will be accepted while an input of 89.3360 would be rejected.)

After you have entered the latitude, press [RETURN] to continue. The latitude will be displayed on the screen with the identifier and the longitude prompt will appear at the bottom of the screen:

LONGITUDE? _____

If entry is declined the program will move back to the latitude prompt.

The data input must be between 0 and 180.0000 or it will be rejected. If the input for minutes or seconds is over 59 then it will be rejected. (i.e. An input of 179.0046 will be accepted while an input of 178.6046 would be rejected.)

After you have entered the longitude, press [RETURN] to continue. The longitude will be displayed under the identifier and latitude. The magnetic variation will be prompted for at the bottom of the screen:

MAGNETIC VARIATION? ___

If entry is declined the program will move back to the longitude prompt.

The data line is 3 spaces long to allow to up to 2 numerical characters and one sign character. The sign character may be +, W, [SPACE], -, or E. The sign character may be entered before or after the numerical portion of the variation. A variation of 4° East can be entered as "-4", "E4", "4-", or "4E". The program will display the entries such as "4-" and "4E" on the data line as "4 -" and "4 E". That is so a confusing entry such as "4-7" or "4E7" can not be accidently entered. The variation, 12° West, can be entered as "12", "+12", "W12", "12+", or "12W".

Press [RETURN] to continue. The data for the navaid or airport will be displayed on the screen. The prompt at the bottom of the screen will ask:

IS THE DATA CORRECT [Y]/[N]?

If you answer "No" by pressing [N] then the variation will be reprompted. If you press [Y] for "Yes" the data will be stored in the nav data file and you will be prompted for the identifier of the next fix.

To return to the Airnav Data Menu it is necessary to be at the identifier prompt. It is declining data entry at this point that tells the program you want the Airnav Data Menu. If you have entered data you do not want and are at the "data correct?" prompt you will have to press [N], decline variation entry, decline longitude entry, and decline latitude entry. You'll then be at the identifier prompt and declining that entry you'll arrive at the Airnav Data Menu. You can abort data entry at any point by continually declining entries until you arrive back at the Airnav Data Menu.

## DATA ENTRY ERROR MESSAGES

If more than 250 entries are attempted the following message will appear at the top of the screen:

FULL MEMORY

---

Whenever an error message is displayed the following message will be at the bottom of the screen:

Push any key to continue-

The program will not allow an identifier to be duplicated. The same identifier may be used for an airport and a navaid, but two airports or navaids may not have the same identifier. If an attempt is made to enter an identifier already being used the following message will appear in the middle of the screen:

I ALREADY HAVE " ID " STORED IN WITH

THE NAV DATA!

The " ID " will be the identifier that would have been duplicated.

## SAMPLE FLIGHT

We will be using the following flight and its fixes as an example:

> We will depart from the McGhee Tyson airport at Knoxville, Tennessee. Using RNAV we will fly direct to Cowan Intersection, using a waypoint off of the Hinch Mountain Vortac. From Cowan we'll fly V-54N to the Rocket Vortac and V-54 to the Muscle Shoals Vortac. Then we'll land at the Muscle Shoals airport in Alabama.

The coordinates for the airports are:

| | | | |
|---|---|---|---|
| TYS | LAT 35° 48′ 45" | LNG 83° 59′ 34" | VAR 1° W |
| MSL | LAT 34° 44′ 43" | LNG 87° 36′ 37" | VAR 1° E |

The coordinates for the navaids are:

| | | | |
|---|---|---|---|
| TYS | LAT 35° 54′ 17" | LNG 83° 53′ 41" | VAR 1° W |
| HCH | LAT 35° 46′ 51" | LNG 84° 58′ 43" | VAR 1° E |
| CHA | LAT 34° 57′ 40" | LNG 85° 09′ 12" | VAR 1° E |
| RQZ | LAT 34° 47′ 49" | LNG 86° 38′ 02" | VAR 2° E |
| MSL | LAT 34° 42′ 24" | LNG 87° 29′ 29" | VAR 1° E |

SAMPLE DATA ENTRY

In this example we'll enter the data for the Knoxville Vortac, TYS. Starting from the Airnav Data Menu, press [1]. The screen will look like this:

ENTRY: 1 FORMAT: DD° MM′ SS"

NAVAID DATA ENTRY

IDENTIFIER? ___

Type in "TYS". Press [RETURN]. The screen will now look like:

ENTRY: 1 FORMAT: DD° MM′ SS"

NAVAID DATA ENTRY

IDENTIFIER: TYS

LATITUDE? _____

Type in "35.5417" and press [RETURN]. The screen will now look like:

```
ENTRY: 1          FORMAT: DD° MM′ SS"
_____________________________________
NAVAID   DATA  ENTRY


IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE? ________
```

To show how easy it is to correct a mistake lets enter incorrect data for the longitude. Enter "85.341" and press [RETURN]. The screen will be:

```
ENTRY: 1          FORMAT: DD° MM′ SS"
_____________________________________
NAVAID   DATA  ENTRY


IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE:  85° 34′ 10"

MAGNETIC VARIATION? ___
```

To correct the entry we will have to back up to the longitude prompt by declining entry. Press [RETURN] without any data entry and we will be at the prior screen:

ENTRY: 1 FORMAT: DD° MM′ SS"

NAVAID DATA ENTRY

IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE? _____

This time input the correct data by typing "83.5341". Press [RETURN] and we are back at the variation prompt:

ENTRY: 1 FORMAT: DD° MM′ SS"

NAVAID DATA ENTRY

IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE: 83° 53′ 41"

MAGNETIC VARIATION? ___

Type "1". Press [RETURN] and the screen will now be:

```
ENTRY: 1          FORMAT: DD° MM′ SS"
-------------------------------------------
NAVAID   DATA  ENTRY

IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE:  83° 53′ 41"

MAGNETIC VARIATION: 1° W

IS THE DATA CORRECT [Y]/[N]?
```

The data looks good, so press the [Y] key. The screen with the identifier prompt will appear. Go ahead and enter the data for Hinch Mountain Vortac (HCH) and Muscle Shoals Vortac (MSL). Do not enter Rocket (RQZ) at this time, we'll do it later. Enter the following for the Chattanooga Vortac so we can edit it later:

```
CAA     LAT 35° 57′ 40"     LNG 108° 09′ 12"     VAR 1° E
```

After entering the navaid data, decline entry at the identifier prompt to return to the Airnav Data Menu. Press [2] and the identifier prompt for airport data entry will be displayed. Enter the data for the airports, TYS and MSL. When you type in the identifier, "TYS", you will see:

```
IDENTIFIER?  TYS_
```

You could enter the identifier as " TYS", but the program will insert the blank space for you. The rest of the data entry is identical to entering data for the navaids.

## NAV DATA EDITOR

Option [3] EDIT of the Airnav Data Menu will give you the following Edit Menu:

```
[1]NAVAID [2]AIRPORT [3]FORMAT [0]MENU
-------------------------------------
EDIT NAV DATA
```

YOUR CHOICE?

[0] MENU will take you back to the Airnav Data Menu.

[1] NAVAID & [2] AIRPORT will allow you to edit the data that has been entered into the nav data file. They both function identically, except [1] will edit navaids and [2] will edit airports.

[3]FORMAT will take you to the Format Menu:

```
ENTRIES: 6        FORMAT: DD° MM′ SS"
-------------------------------------
LAT/LNG FORMAT

[0] RETURN TO MENU

[1] DEGREES, MINUTES, & SECONDS
    FORMAT:  DD° MM′ SS"
         Example: 90° 38′ 47"
    ENTRY FORM:  DD.MMSS
         Example:  90.3847

[2] DEGREES, MINUTES, & TENTHS
    FORMAT: DD° MM.d′
         Example: 90° 38.8′
    ENTRY FORM: DD.MMd
         Example: 90.388
```

You may change the degree format you are using even if data has already been entered and stored.

The [0] option will take you back to the Edit Menu.

When you use the [1] or [2] option the following prompt will appear at the bottom of the menu:

YOUR CHOICE IS FORMAT OPTION #1(or 2) [Y]/[N]

If the answer is [N] then the Format Menu is offered again. If the answer is [Y] and the format option is the same as the current format you will be returned to the Edit Menu (the same as the [0] option). If the format option is different than the current format the data will be reformatted before the Edit Menu is redisplayed.

When you change the format from using seconds to using tenths of a minute, 90° 38′ 47" will become 90° 38.8′. If you change it back, 90° 38.8′ will then be 90° 38′ 48" which is slightly different than what you started with. This difference can be as much as 3 seconds, which is insignificant as the most 3 seconds can be is about 300 ft.

The program will change each data entry and store the file on the data diskette. The more data you have stored in the nav data file the longer it will take to reformat. While the file is being reformatted the AIR NAVIGATION/*RNAV* graphics will be displayed with the following message at the bottom:

I AM REFORMATTING
THE NAV DATA!

## EDITING THE NAV DATA

Editing the airports is the same procedure as the navaids. Even though navaids will be used in the explaination, the same rules apply to both.

Pushing the Edit Menu's [1] option will allow us to edit navaids. The following screen will be displayed:

NAVAID

EDIT NAV DATA

NAVAID IDENTIFIER? ___

If this is not the option you wanted, you may return to the Edit Menu simply by declining entry

If you try to call up a fix that is not in the file an error message will be displayed. As an example if we tried to edit data for the Memphis Vortac which is not in the file, the following message would be displayed in the center of the screen:

MEM IS NOT IN
THE NAV DATA!

Push any key to continue-

When you push any key the former display prompting for a navaid identifier will redisplayed.

To call a fix for editing, type the identifier and press [RETURN]. It will be displayed with the following options:

[1]ID [2]LAT [3]LNG [4]VAR [5]DEL [0]EXIT

EDIT NAV DATA

IDENTIFIER: TYS

LATITUDE: 35° 54′ 17"

LONGITUDE: 83° 53′ 41"

MAGNETIC VARIATION: 1° W

WHICH DO YOU WANT TO CHANGE?

[0] EXIT will give you the prior display prompting for a navaid identifier.

[1] ID will display the prompt for a new identifier at the bottom of the screen. All the data will remain on the screen. The prompt is:

IDENTIFIER? ___

The program will not accept an identifier that already has been used for a navaid, including the current identifier that is being edited. As an example, if we tried to change TYS to HCH the following would be displayed:

TYS

EDIT NAV DATA

I ALREADY HAVE HCH STORED IN WITH
THE NAV DATA!

Push any key to continue-

When you continue, the program will return to the prompt for the navaid to be edited:

NAVAID IDENTIFIER? ___

[2] LAT will display the prompt for reentering the latitude.

[3] LNG will display the prompt for changing the longitude.

[4] DEL is for delete. When you press [4] the following question will be asked at the bottom of the display (the TYS identifier is used for illustration):

YOU WANT TO DELETE TYS [Y]/[N]?

If [N] is the answer the question "WHICH DO YOU WANT TO CHANGE?" will be redisplayed. If the answer is [Y] that entry will be deleted and the program will return to the Edit Menu.

SAMPLE EDIT

For an example, we'll change the incorrect entry for the Chattanooga Vortac:

CAA LAT 35° 57′ 40" LNG 108° 09′ 12" VAR 1° E

to the correct entry:

CHA LAT 34° 57′ 40" LNG 85° 09′ 12" VAR 1° E

Starting from the Main Menu we need to call the Airnav Data Menu by pressing [2]. Next go to the Edit Menu with key [3]. The choices at the top of the screen will be:

```
[1]NAVAID [2]AIRPORT [3]FORMAT [0]MENU
```

```
EDIT NAV DATA
```

The fix we'll be editing is a navaid so we need to press [1]. The word "NAVAIDS" will appear at the top line to let you know that the program does indeed expect to edit a navaid. At the bottom of the screen, you'll be asked:

```
NAVAID IDENTIFIER? ___
```

If you pressed the [2] key by mistake, you would see a prompt for the airport identifier. To get back to the Edit Menu just decline entry. Press [1] and you'll see the prompt for the navaid identifier.

Type in "CAA" and press [RETURN] and you will see the following:

```
[1]ID [2]LAT [3]LNG [4]VAR [5]DEL [0]EXIT
```

```
EDIT NAV DATA


IDENTIFIER: CAA

LATITUDE: 35° 57' 40"

LONGITUDE:  108° 09' 12"

MAGNETIC VARIATION: 1° E


WHICH DO YOU WANT TO CHANGE?
```

You are now ready to edit the data for the Chattanooga navaid.

Press the [1] key and the display will change to:

CAA

EDIT NAV DATA

IDENTIFIER: CAA

LATITUDE: 35° 57′ 40"

LONGITUDE: 108° 09′ 12"

MAGNETIC VARIATION: 1° E

IDENTIFIER? ___

Type in the correct identifer for Chattanooga, "CHA", and press [RETURN]. The screen will display the change and ask for the next choice:

[1]ID [2]LAT [3]LNG [4]VAR [5]DEL [0]EXIT

EDIT NAV DATA

IDENTIFIER: CHA

LATITUDE: 35° 57′ 40"

LONGITUDE: 108° 09′ 12"

MAGNETIC VARIATION: 1° E

WHICH DO YOU WANT TO CHANGE?

To correct the latitude, press the [2] key. You will be asked for the new latitude:

CHA

EDIT NAV DATA

IDENTIFIER: CHA

LATITUDE: 35° 57′ 40"

LONGITUDE: 108° 09′ 12"

MAGNETIC VARIATION: 1° E

LATITUDE? _____

Type in the correct latitude, "34.574" and press [RETURN]. The screen will display the correction and ask for the next move:

[1]ID [2]LAT [3]LNG [4]VAR [5]DEL [0]EXIT

EDIT NAV DATA

IDENTIFIER: CHA

LATITUDE: 34° 57′ 40"

LONGITUDE: 108° 09′ 12"

MAGNETIC VARIATION: 1° E

WHICH DO YOU WANT TO CHANGE?

It will be the same procedure for the longitude after pressing [3]. If needed to correct the magnetic variation, it would also be the same procedure except for starting by pressing the [4] key. After correcting the longitude the screen will show:

[1]ID [2]LAT [3]LNG [4]VAR [5]DEL [0]EXIT

EDIT NAV DATA

IDENTIFIER: CHA

LATITUDE: 34° 57′ 40"

LONGITUDE: 85° 09′ 12"

MAGNETIC VARIATION: 1° E

WHICH DO YOU WANT TO CHANGE?

It looks right and to exit we press [0]. The program will take us back to the Edit Menu:

[1]NAVAID [2]AIRPORT [3]FORMAT [0]MENU

EDIT NAV DATA

YOUR CHOICE?

VIEWING THE NAV DATA

After entering the data it is sometimes necessary to look and see exactly what has been entered into the nav data file. A list of the fixes entered can be very helpful. The program provides means for listing the fixes on the screen or printing them on paper.

After entering the nav data and before exiting back to the Main Menu, the data will be stored in the file unsorted in the same order it was entered. The data will be scrolled or printed in the same unsorted order. Whenever you exit back to the Main Menu the data will be sorted and stored on the data diskette. If you then scroll or print the data it will be in alphabetical order.

By choosing the option [4] VIEW in the Airnav Data Menu you will be given the following menu:

```
[1]NAV[2]ARP[3]SCROLL[4]PRINT [0]MENU
_____________________________________
VIEW   NAV   DATA
```

YOUR CHOICE?

[0] MENU will take you back to the Airnav Data Menu.

[1] NAV & [2] ARP will allow you to look at the coordinates for a single navaid or airport. They both work identically, except one allows navaids to be shown and the other airports. For illustration the airport option will be shown. Pressing [2] will display the following prompt:

```
AIRPORT
_____________________________________
VIEW   NAV   DATA
```

AIRPORT IDENTIFIER? ____

As an example,if you wanted to look at the coordinates for McGhee Tyson Airport type in "TYS" and press [RETURN]. The data would be displayed:

AIRPORT

VIEW NAV DATA

IDENTIFIER: TYS

LATITUDE: 35° 48′ 45"

LONGITUDE: 83° 59′ 34"

MAGNETIC VARIATION: 1° W

Push any key to continue-

Pushing any key will take you back to the former display giving you the choice to look at another airports coordinates:

AIRPORT

VIEW NAV DATA

AIRPORT IDENTIFIER? ____

To return to the View Nav Data Menu all you have to do is decline entry at the above prompt.

## SCROLLING THE NAV DATA

[3] SCROLL will scroll the data filed in the nav data file on the screen.

Holding down the [CTRL] key and pressing the [1] key at the same time will temporarily stop the screen. [CTRL][1] will also restart the scroll. The data will be scrolled from the bottom of the screen and will disappear off the screen at the top just under the display title.

After the program has scrolled all the entries up and off the screen the program will return to the View Nav Data Menu.

If you want to return to the View Nav Data Menu before the scroll is finished, press [0]. However, if the screen has been stopped with [CTRL][1] it will have to be restarted before the program will be able to quit the scroll and return to the menu.

Below is an example of what the display will look like during the scroll:

[CTRL][1] STOP/START SCROLL  [0] QUIT

SCROLLING NAV DATA

| | |
|---|---|
| CHA - NAVAID | VAR 1° E |
| LAT 34° 57′ 40" | LNG 85° 09′ 12" |
| HCH - NAVAID | VAR 1° E |
| LAT 35° 46′ 51" | LNG 84° 58′ 43" |
| MSL - NAVAID | VAR 1° E |
| LAT 34° 42′ 24" | LNG 87° 29′ 29" |
| MSL - AIRPORT | VAR 1° E |
| LAT 34° 44′ 43" | LNG 87° 36′ 37" |

## PRINTING THE NAV DATA

[4] PRINT will print the nav data for you. It will print 50 nav fixes per page and number the pages. While the data is being printed the AIR NAVIGATION/*RNAV* graphics will be displayed with the following message at the bottom of the screen:

I AM PRINTING
THE NAV DATA!

If there is a problem with the printer (such as it being turned off, deselected, or nonexistent) the program will display the View Nav Data Menu after attempting to print.

If you wish to discontinue the printout before it is finished, push the [ESC] key.

If the printer codes have not been entered, the data will be printed in the default font and margin of your printer and the degree symbol will not be printed. The following is an example of the printout without degree symbols:

NAV DATA page 1 of 1

| FACILITY | VARIATION | LATITUDE | LONGITUDE |
|---|---|---|---|
| CHA - NAVAID | 1 E | 34 57' 40" | 85 09' 12" |
| HCH - NAVAID | 1 E | 35 46' 51" | 84 58' 43" |
| MSL - NAVAID | 1 E | 34 42' 24" | 87 29' 29" |
| MSL - AIRPORT | 1 E | 34 44' 43" | 87 36' 37" |
| TYS - NAVAID | 1 W | 35 54' 17" | 83 53' 41" |
| TYS - AIRPORT | 1 W | 35 48' 45" | 83 59' 34" |

See section VII for instructions and suggestions on entering printer code for the degree character and printer initialization. The following is the printout with the degree character:

NAV DATA page 1 of 1

| FACILITY | VARIATION | LATITUDE | LONGITUDE |
|---|---|---|---|
| CHA - NAVAID | 1° E | 34° 57′ 40" | 85° 09′ 12" |
| HCH - NAVAID | 1° E | 35° 46′ 51" | 84° 58′ 43" |
| MSL - NAVAID | 1° E | 34° 42′ 24" | 87° 29′ 29" |
| MSL - AIRPORT | 1° E | 34° 44′ 43" | 87° 36′ 37" |
| TYS - NAVAID | 1° W | 35° 54′ 17" | 83° 53′ 41" |
| TYS - AIRPORT | 1° W | 35° 48′ 45" | 83° 59′ 34" |

If you are using a 40 column printer the data will print out in a readable format. The program will still attempt to page the data, which is not very practical with 40 columns, but still usable. This is what it will look like:

NAV DATA page 1 of 1

FACILITY VARIATION
LATITUDE LONGITUDE

CHA - NAVAID 1° E
34° 57′ 40" 85° 09′ 12"
HCH - NAVAID 1° E
35° 46′ 51" 84° 58′ 43"
MSL - NAVAID 1° E
34° 42′ 24" 87° 29′ 29"
MSL - AIRPORT 1° E
34° 44′ 23" 87° 36′ 33"
TYS - NAVAID 1° W
35° 54′ 17" 83° 53′ 41"
TYS - AIRPORT 1° W
35° 48′ 45" 83° 59′ 34"

## IV. ROUTE ENTRY

### TYPES OF NAV FIXES

The AIR NAVIGATION/*RNAV* program allows input of four different types of fixes.

1. AIRPORTS may be used for the departure and destination points as well as enroute fixes. They will be identified by their 3 or 4 character identifier.

2. NAVAIDS can be used for departure and destination points, enroute fixes, and as a reference fix for waypoints and intersections. They will be identified by their 3 letter identifier.

3. INTERSECTIONS are enroute fixes, but may be used for departure and destination points. An intersection needs a reference navaid with an offsetting radial and distance. In our sample flight we will be navigating to the COWAN Intersection which is defined as being 38 NM from the Chattanooga Vortac on its 227° radial. It would be printed:

   COWAN INTERSECTION * CHA 277.0° 38.0 NM

   If you want to enter a waypoint (that has already been computed) by its reference navaid, radial, and distance it will need to be entered as an intersection.

4. WAYPOINTS are enroute fixes and require a reference navaid. The program will compute the bearing and distance for the offset of the waypoint from the navaid. Waypoints will be identified by the identifier of the reference navaid followed by the radial and distance from the navaid to the waypoint. The waypoint off of the Hinch Mountain Vortac used in our sample flight would be printed:

   HCH WAYPOINT 153.1° 19.3 NM

   If the departure or destination point is an airport, the program will allow the input of a terminal waypoint that is offset over the airport. In our sample flight we use the Knoxville Vortac as a terminal waypoint for the McGhee Tyson Airport. The airport and terminal waypoint are printed together for easy identification:

   TYS AIRPORT * TYS 221.9° 7.3 NM

DEPARTURE POINT

The very first fix of a route is the departure point. AIR NAVIGATION/*RNAV* will first ask you what type of fix you want to use for a departure point. Aircraft always use an airport for the departure point, however for planning purposes the program will also let you use a navaid or an intersection. Pressing [1] will indicate a navaid. Pressing [2] will indicate an airport. And by pressing [3] you'll indicate an intersection. If entry is declined, the program will return to the Main Menu. The display prompting for the departure fix is:

[1] NAV [2] ARP [3] INTERSECTION

ROUTE PLANNING

DEPARTURE POINT ([1]-[3])?

After choosing the type of fix for the departure point, you will be prompted for its identifier. Declining entry will return you to the departure fix prompt. As an example, if the [2] key is pressed the prompt will be:

DEPARTURE AIRPORT

ROUTE PLANNING

IDENTIFIER? ____

TERMINAL WAYPOINT

If the departure point is an airport, the program will prompt for a reference navaid for a terminal waypoint. If the departure point is not an airport it will go to the enroute fix prompt. If a terminal waypoint is not desired, decline entry and the program will go to the eroute fix prompt. The top line of the prompt display will include the identifier of the airport, and in the example it is indicated by (ID):

(ID) TERMINAL WAYPOINT

ROUTE PLANNING

IDENTIFIER? ___

ENROUTE FIX ENTRIES

The program will be prompting for the navigation fixes that will be used enroute. The fixes will need to be entered in the sequential order that they will be flown. You will be first asked for the type of fix that will be used next. In the prompt the last fix will be given and the next fix asked for. The last fix is given so that it will be easy to remember where you are in the route. The prompt will be:

[1]NAV[2]ARP[3]INTERSECTION[4]WAYPOINT

ROUTE PLANNING

LAST FIX WAS (ID)

NEXT FIX ([1]-[4])?

If a navaid or airport is chosen for the next fix, then the program will ask for the identifier. Whenever the identifier is prompted for, the type of fix will be identified above it. If it is the wrong type of fix then decline entry. If input is declined the program will return to the previous prompt for the type of fix.

If the next fix is an airport the prompt display will be:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS (ID)

NEXT FIX IS AN AIRPORT

IDENTIFIER? ____

If the next navigation fix is a navaid the prompt will be:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS (ID)

NEXT FIX IS A NAVAID

IDENTIFIER? ___

The program will search the nav data file for the identifier and if it isn't found it will prompt for the coordinates and variation. The entry for them is the same format and procedure as found in the AIRNAV DATA portion of the program. After the data is entered and the program told that the data is correct you will be given the option to store the fix and its coordinates in the nav data file. The following prompt will appear at the bottom of the display:

STORE WITH THE NAV DATA [Y]/[N]?

If the choice is [Y] the data will be stored in the nav data file. The [N] choice will store the coordinates in the Route file. After the decision to store the nav data has been made the program will then prompt for the next fix.

ENROUTE INTERSECTION

When the next fix is going to be an intersection the program will prompt for the name of the intersection. Intersection identifers are given on the charts as a 5 letter name. The program allows for an entry of up to 5 letters.

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS (ID)

NEXT FIX IS AN INTERSECTION

IDENTIFIER? _____

The program will prompt for the reference fix next. If entry is declined at this point the program will return to the prompt asking for the next enroute fix. When the identifier for the reference fix is entered the program will search the nav data file for it. If the data isn't located, the program will prompt for the coordinates and give you a chance to store them in the nav data file.

Once the reference fix has been entered the program will prompt for the radial from the reference fix to the intersection. The data will be prompted for and scrolled up on the screen in the same manner as the coordinates. Below is the prompt for the radial (the identifier already has been prompted for and entered):

( ID ) REFERENCE NAV AID

ROUTE PLANNING

REFERENCE: (ID)

RADIAL? _____

Five spaces are allowed for the radial which may be between 0° and 360°. Four spaces are allowed for the distance and may be between 0 and 99.9 NM. The following is the prompt display for the distance between the reference navaid and the intersection:

( ID ) REFERENCE NAV AID

ROUTE PLANNING

REFERENCE: (ID)

RADIAL: DD.d°

DISTANCE? _____

If input is declined for the radial or distance the program will back up to the last prompt. As an example, if entry is declined at the distance prompt the program will back up and prompt for the radial again.

After the distance has been entered the program will ask if the data is correct:

( ID ) REFERENCE NAV AID

ROUTE PLANNING

REFERENCE: (ID)

RADIAL: DD.d°

DISTANCE: SS.s NM

IS THE DATA CORRECT [Y]/[N]?

If the answer is [N] the program will back up and prompt for the distance again. If the data is correct, press [Y], and the program will store the intersection data in the route file and prompt for the next fix.

ENROUTE WAYPOINT

If the next enroute navigation fix is going to be a waypoint the program will prompt for the reference navaid:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS (ID)

NEXT FIX IS A WAYPOINT

IDENTIFIER? ___

If the navaid can't be found in the nav data file, the program will prompt for the coordinates and variation, and give you a chance to store it in the nav data file.

The program will store all the waypoints in the route file that have been inputed. However, the program will ignore impractical waypoints when calculating the route. The following two situations are considered impractical:

1. A waypoint that would be behind the last fix.

2. A waypoint that would be ahead of the next non-waypoint fix.

The way the program calculates the waypoint is by using the radial from the reference navaid that is perpendicular to the route. Because the intersecting radial will always be perpendicular it is easy to note the physical location of the waypoint on your navigation chart.

DESTINATION POINT

The destination point is entered in as an enroute fix. When the next enroute fix prompt is displayed, decline entry and the program will exit the route planning. If the destination fix was an airport the program will prompt for a terminal waypoint. If a terminal waypoint is not desired just decline the entry.

MAXIMUM ENTRIES

The number of fixes that can be entered will vary on the type of fixes that are entered. The route file has room in it for 249 characters. Each fix requires 6 characters. An intersection requires an additional 13 characters. Every time the coordinates for a navaid or airport are stored in the route file instead of the nav data file another 14 characters will be needed. If the route consists of only airports, navaids, and waypoints that are in the nav data file then 41 fixes will be able to be entered. If none of those are terminal waypoints, then that will be 40 legs. If there isn't

any room left in the route file for the impending entry the program will display the following screen:

NAVIGATION FIX

ROUTE PLANNING

NO MORE ROOM!

Push any key to continue-

FLIGHT ROUTE PREVIEW

After the route has been entered the program will print it on the screen so that you will be able to check it for correctness. The route will be scrolled up the screen from the bottom. If the route is over 12 legs the first part of the route will be scrolled off the screen. If you want to stop the scroll press [CTRL][1]. [CTRL][1] will start the scroll again. After the route has been listed on the screen the question will be asked:

IS THE DATA CORRECT [Y]/[N]?

If you answer [N] the program will start over with the route entries. If the answer is [Y] the program will continue on to the Navigation Menu. If there was data entered during the route entry which was stored into the nav data file it will be sorted and stored to the data diskette before the Navigation Menu is displayed or the route entries are started again.

## SAMPLE FLIGHT

We will be using the following flight and its fixes as an example:

> We will depart from the McGhee Tyson airport at Knoxville, Tennessee. Using RNAV we will fly direct to Cowan Intersection, using a waypoint off of the Hinch Mountain Vortac. From Cowan we'll fly V-54N to the Rocket Vortac and V-54 to the Muscle Shoals Vortac. Then we'll land at the Muscle Shoals airport in Alabama.

The coordinates for the airports and navaids were entered during the sample data entry in section III, except for the Rocket Vortac data:

RQZ LAT 34° 47′ 49" LNG 86° 38′ 02" VAR 2° E

## SAMPLE FLIGHT ENTRY

Pressing [1] for Route Entry while in at the Main Menu will give the prompt for the type of fix to be used for the departure point:

```
[1] NAV [2] ARP [3] INTERSECTION

ROUTE PLANNING

DEPARTURE POINT ([1]-[3])?
```

The departure point is McGhee Tyson airport at Knoxville and pressing [2] will tell the program to expect an airport:

DEPARTURE AIRPORT

ROUTE PLANNING

IDENTIFIER? ____

Type in the identifier, "TYS", and press [RETURN]. The program will then prompt for a terminal waypoint:

TYS TERMINAL WAYPOINT

ROUTE PLANNING

IDENTIFIER? ___

By using the Knoxville Vortac as a waypoint located at McGhee Tyson, distance and groundspeed readouts will be possible. So type in the identifier for the Knoxville Vortac, "TYS", and press [RETURN]. The program will prompt for the next enroute fix:

[1]NAV[2]ARP[3]INTERSECTION[4]WAYPOINT

ROUTE PLANNING

LAST FIX WAS TYS

NEXT FIX ([1]-[4])?

The next will be a waypoint using the Hinch Mountain Vortac. Press [4] and the program will prompt for the navaid to be used for the waypoint:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS TYS

NEXT FIX IS A WAYPOINT

IDENTIFIER? ___

Type in the Hinch Mountain identifier, "HCH" and press [RETURN]. The program will prompt for the next fix, which will be COWAN intersection. Press [3] and the program will prompt for the identifier:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS HCH

NEXT FIX IS AN INTERSECTION

IDENTIFIER? _____

Type in "COWAN" and press [RETURN]. The program will prompt for the reference navaid for the intersection:

COWAN REFERENCE NAV AID

ROUTE PLANNING

IDENTIFIER? ___

Type in the Chatanooga Vortac identifier, "CHA", and press [RETURN]. The program will prompt for the radial from the navaid to the intersection:

COWAN REFERENCE NAVAID

ROUTE PLANNING

REFERENCE: CHA

RADIAL? _____

Type in the 277° radial, "277", and press [RETURN]. The next prompt will be for the distance between the navaid and the intersection:

COWAN REFERENCE NAVAID

ROUTE PLANNING

REFERENCE: (ID)

RADIAL: 277.0°

DISTANCE? ____

Type in 38 NM, "38", and press [RETURN]. The program will ask if you are sure of the data:

COWAN REFERENCE NAVAID

ROUTE PLANNING

REFERENCE: (ID)

RADIAL: 277.0°

DISTANCE: 38.0 NM

IS THE DATA CORRECT [Y]/[N]?

If the data is correct press [Y]. The program will prompt for the next fix which will be the Rocket Vortac. Press [1] and the next prompt will be for the navaid identifier:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS COWAN

NEXT FIX IS A NAVAID

IDENTIFIER? ___

Enter the identifier for the Rocket Vortac, "RQZ", and press [RETURN]. This fix is not in the nav data file, so the program will prompt for its coordinates starting with the latitude:

NAVIGATION FIX

ROUTE PLANNING
FORMAT: DD° MM′ SS"

IDENTIFIER: RQZ

LATITUDE? _____

Type in "34.4749" and press [RETURN]. The program will prompt for the longitude:

NAVIGATION FIX

ROUTE PLANNING
FORMAT: DD° MM′ SS"

IDENTIFIER: RQZ

LATITUDE: 34° 47′ 49"

LONGITUDE? _____

Type in "86.3802" and press [RETURN]. The program will prompt for the magnetic variation:

NAVIGATION FIX

ROUTE PLANNING
FORMAT: DD° MM′ SS"

IDENTIFIER: RQZ

LATITUDE: 34° 47′ 49"

LONGITUDE: 86° 38′ 02"

MAGNETIC VARIATION? ___

Type "E2". Press [RETURN] and the screen will now be:

NAVIGATION FIX

ROUTE PLANNING
FORMAT: DD° MM′ SS"

IDENTIFIER: RQZ

LATITUDE: 34° 47′ 49"

LONGITUDE: 86° 38′ 02"

MAGNETIC VARIATION: 2° E

IS THE DATA CORRECT [Y]/[N]?

The data looks good, so press the [Y] key. Store the RQZ data in the nav file by pressing the [Y] key at this prompt:

STORE WITH THE NAV DATA [Y]/[N]?

The program will prompt for the next enroute fix, which will be the Muscle Shoals Vortac. Press [1] and the program will prompt for the navaid identifer:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS RQZ

NEXT FIX IS A NAVAID

IDENTIFIER? ___

Type in the Muscle Shoals Vortac identifier, "MSL", and press [RETURN]. The program will prompt for the next enroute fix. Press [2] because the next fix will be the destination airport:

NAVIGATION FIX

ROUTE PLANNING

LAST FIX WAS MSL

NEXT FIX IS AN AIRPORT

IDENTIFIER? ____

Enter the identifer for the Muscle Shoals, Alabama airport, "MSL" and press [RETURN]. The program will prompt for the next enroute fix. The last fix was the destination, so decline entry by just pressing [RETURN] and the program will exit the enroute fix entry mode. Because the last fix is an airport the program will give the opportunity to enter a terminal waypoint. The terminal waypoint isn't needed so decline entry by pressing [RETURN]. The route will then be displayed for correctness:

TYS TO MSL

FLIGHT ROUTE

TYS AIRPORT * WAYPOINT TYS
HCH WAYPOINT
COWAN INTERSECTION
RQZ NAVAID
MSL NAVAID
MSL AIRPORT

IS THE DATA CORRECT [Y]/[N]?

Press [Y] and the program will save the nav data file (because RQZ was added to it) and then go to the Navigation Menu.

## V. NAVIGATION MENU

TYS TO MSL

NAVIGATION

[0] MENU

[1] VIEW

[2] PRINT

[3] REVERSE

[4] SAVE

[0] MENU

The [0] key will allow you to exit the Navigation Menu back to the Main Menu.

[1] VIEW

The [1] key will display the route on the screen, along with the magnetic courses and distances for each leg. The data will be scrolled from the bottom of the screen. The maximum number of legs which will be visible on the screen at one time is seven. However, when the data stops scrolling there will be five legs left on the screen. The [CTRL][1] key combination will stop and restart the scroll if it is desirable to pause the screen.

Each navigational fix used will be listed in sequence in the format that is explained under TYPES OF NAV FIXES in section IV. In between each nav fix will be the magnetic course(s), the leg distance, and the remaining distance. As an example, the navigation data for the leg between McGhee Tyson airport and the waypoint off of Hinch Mountain Vortac is:

MC=245°/243° DIST=44 NM REM=148 NM

While using the Knoxville Vortac (TYS) for navigating the magnetic course will be 245°. However, because of the difference in the magnetic variation at Hinch Mountain, the magnetic course will be 243° when using the Hinch Mountain Vortac. The distance between McGhee Tyson airport and the Hinch Mountain waypoint is 44 nautical miles. After reaching the Hinch Mountain waypoint the remaining distance will be 148 nautical miles.

It will take your computer a small amount of time to do the necessary computations. Because of that there will be a small delay in starting the display after the [1] key is pressed.

The following display is the sample flight:

```
                    TYS TO MSL
_____________________________________________
                 NAVIGATION

                 T/DIST: 192 NM


TYS AIRPORT * TYS 221.9° 7.3 NM
 MC=245°/243°  DIST=44 NM  REM=148 NM
HCH WAYPOINT 153.1° 19.3 NM
 MC=243°  DIST=61 NM  REM=87 NM
COWAN INTERSECTION * CHA 277.0° 38.0 NM
 MC=246°/245°  DIST=38 NM  REM=49 NM
RQZ NAVAID
 MC=261°/262°  DIST=43 NM  REM=6 NM
MSL NAVAID
 MC=290°  DIST=6 NM
MSL AIRPORT

      Push any key to continue-
```

[2] PRINT

If you are using a printer, the [2] key will tell the program to print the flight. If your printer isn't online the program will re-display the Navigation Menu after attempting to print. On the next page is the printout for the sample flight:

```
                    TYS TO MSL
                      192 NM
=========================================

 TYS AIRPORT * TYS 221.9° 7.3 NM
  MC=245°/243°  DIST=44 NM  REM=148 NM
 HCH WAYPOINT 153.1° 19.3 NM
  MC=243°  DIST=61 NM  REM=87 NM
 COWAN INTERSECTION * CHA 277.0° 38.0 NM
  MC=246°/245°  DIST=38 NM  REM=49 NM
 RQZ NAVAID
  MC=261°/262°  DIST=43 NM  REM=6 NM
 MSL NAVAID
  MC=290°  DIST=6 NM
 MSL AIRPORT
```

While the flight is being printed the program will display the AIR NAVIGATION/*RNAV* graphics with the following message at the bottom:

```
I'M PRINTING THE
 NAVIGATION FOR
   TYS TO MSL
```

After the flight has been printed the program will return to the Navigation Menu.

[3] REVERSE

Pressing the [3] key will tell the program that the flight navigation should be viewed and/or printed in the opposite direction. The route at the top of the menu will be reversed to show the direction of flight. As an example, if the route was:

```
TYS TO MSL
```

Press the [3] key and it will be:

```
MSL TO TYS
```

By pressing the [3] key again, the route will be reversed again, back to the former direction of flight:

```
TYS TO MSL
```

To print the navigation for the flight from Muscle Shoals to Knoxville, first press the [3] key to reverse the flight. Check the flight direction at the top of the display, and if it is what you wanted press [2] to start the printout. The bottom of the graphic display will read:

I'M PRINTING THE
NAVIGATION FOR
MSL TO TYS

The printout will be:

MSL TO TYS
192 NM

```
MSL AIRPORT
 MC=110°  DIST=6 NM  REM=186 NM
MSL NAVAID
 MC=082°/081°  DIST=43 NM  REM=143 NM
RQZ NAVAID
 MC=065°/066°  DIST=38 NM  REM=105 NM
COWAN INTERSECTION * CHA 277.0° 38.0 NM
 MC=063°  DIST=61 NM  REM=44 NM
HCH WAYPOINT 153.1° 19.4 NM
 MC=063°/065°  DIST=44 NM
TYS AIRPORT * TYS 221.9° 7.3 NM
```

Sometimes when the route is calculated in the opposite direction there will be small differences in the distances, courses, and waypoints. This is because of inherent problems of navigating on a sphere. This is discussed in deeper detail in the Introduction to Navigation in section X.

[4] SAVE

It is possible to save up to 26 flights on the data diskette. The name of the flight file will be the identifiers of the departure and destination points. The file name of the sample flight will be TYSMSL.

Many small airports in the United States have identifiers that begin with a number. These identifiers will not work in a flight filename if they are in the departure position, as DOS II does not allow filenames that begin with a number. If you try to save such a flight, the program will detect the error and put you back to the Main Menu. The flight would then have to be re-entered. The solution is to reverse the flight with the [3] key and the destination airport will become the departure airport. If that airport also begins with a number then a possible solution would be to change one of the identifers by adding a "K" to the front of it.

If a flight from Osceola, Arkansas (7M4) to Little Rock, Arkansas (LIT) had been entered the filename would be "7M4LIT". That would make an illegal filename. By pressing [3] to reverse the flight the filename would become "LIT7M4" which is a legal filename.

The [4] key will display the Flight Index and ask which position to store it in:

SAVE FLIGHT TYSMSL

FLIGHT INDEX

| | |
|---|---|
| [A] EMPTY | [N] EMPTY |
| [B] EMPTY | [O] EMPTY |
| [C] EMPTY | [P] EMPTY |
| [D] EMPTY | [Q] EMPTY |
| [E] EMPTY | [R] EMPTY |
| [F] EMPTY | [S] EMPTY |
| [G] EMPTY | [T] EMPTY |
| [H] EMPTY | [U] EMPTY |
| [I] EMPTY | [V] EMPTY |
| [J] EMPTY | [W] EMPTY |
| [K] EMPTY | [X] EMPTY |
| [L] EMPTY | [Y] EMPTY |
| [M] EMPTY | [Z] EMPTY |

WHICH POSITION?

Pressing the appropriate key, [A] through [Z], will tell the computer which position to store the flight route in. As an example, to store the sample flight (TYSMSL) in position "A", press [A]. The program will then ask:

YOUR CHOICE IS POSITION [A] - [Y]/[N]?

If there is a flight already stored in the position you've chosen, it will be lost when the new flight route is stored. The above question will allow you to double check and prevent loss of data by accidently pressing the wrong key. If the wrong key is pressed, back-up by answering the question with [N], a NO.

If the position is the one you desire, answer [Y], a YES, and the program will store the flight on the data diskette. The program will then return to the Navigation Menu.

If you decide you do not want to store the flight after the Flight Index has been displayed then answer the question, "WHICH POSITION?", by declining entry. You'll be returned to the Navigation Menu.

It is possible to have two different routes from the same departure point to the same destination. Both routes would have the same flight filename. The program recognizes the flight files by the position they are stored in. This makes it possible to file both routes even though the names will be the same when they are listed in the Flight Index. You will have to remember the positions to differentiate them. The program will display the route after loading it, so you can be sure the correct one was loaded.

Be sure that the data diskette is in the disk drive before asking the program to save the flight. Otherwise, the program will return to the Main Menu if it can't find the correct disk and the data will have to be re-entered.

## VI. LOAD FLIGHT

### LOADING THE FLIGHT

Flight routes that have been stored on the data diskette may be loaded into the flight file by choosing the [2] LOAD FLIGHT option in the Main Menu. When the [2] key is pressed the Flight Index will be displayed:

LOAD FLIGHT

FLIGHT INDEX

| | |
|---|---|
| [A] TYSMSL | [N] EMPTY |
| [B] EMPTY | [O] EMPTY |
| [C] EMPTY | [P] EMPTY |
| [D] EMPTY | [Q] EMPTY |
| [E] EMPTY | [R] EMPTY |
| [F] EMPTY | [S] EMPTY |
| [G] EMPTY | [T] EMPTY |
| [H] EMPTY | [U] EMPTY |
| [I] EMPTY | [V] EMPTY |
| [J] EMPTY | [W] EMPTY |
| [K] EMPTY | [X] EMPTY |
| [L] EMPTY | [Y] EMPTY |
| [M] EMPTY | [Z] EMPTY |

WHICH FLIGHT?

Pressing the appropriate key, [A] through [Z], will choose the flight you want to load. In the Flight Menu above, the flight "TYSMSL" is stored in position "A". By pressing [A] that flight route will be loaded into the flight file. The program will preview the flight route on the screen and ask:

THIS THE CORRECT FLIGHT [Y]/[N]?

If the answer is [Y] the program will display the Navigation Menu. If it isn't the correct route, press [N], and you'll be asked again:

WHICH FLIGHT?

To exit back to the Main Menu from the Flight Index decline entry.

The program will not attempt to load an "EMPTY" file. The data diskette will originally have all the files named "EMPTY". There is no provision made for "deleting" a file. The way a flight file is removed is by storing a new flight route in that position.

## VII. PRINTER CODES

### PRINTER MENU

Pressing the [P] key while in the Main Menu will display the current printer codes. The top of the display will be the printer menu. The data diskette originally will have nulls for the printer codes and the Printer Menu will look like this:

[1] SAVE [2] CHANGE [0] MENU

PRINTER CODES

PRINTER INIT: ♦♦♦♦♦♦♦

In decimal: 0,0,0,0,0,0,0

DEGREE CHAR: ♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦

In decimal: 0,0,0,0,0,0,0

0,0,0,0,0,0,0

The [0] key will take you back to the Main Menu.

If there have been any changes to the printer codes, pressing the [1] key will save them to the data diskette. The program will return to the Main Menu after saving the data. Changes must be saved to the data diskette first for them to be used in the program. If [1] is pressed without any changes having been made, the program returns to the Main Menu.

Pressing the [2] key will allow changes to be made to the printer codes. Changes for the printer initialization will be made first, followed by changes in the degree symbol. After the changes have been made or declined the Printer Menu will be made available again.

PRINTER INITIALIZATION

After pressing [2] the display will prompt for the new printer initialization code.

PRINTER CODES

PRINTER INIT: ♦♦♦♦♦♦♦

In decimal: 0,0,0,0,0,0,0

DEGREE CHAR: ♦♦♦♦♦♦♦♦♦♦♦♦♦♦

In decimal: 0,0,0,0,0,0,0

0,0,0,0,0,0,0

INIT?■

If input is declined the initialization code will not be changed and the program will prompt for the degree symbol code.

The input may be any character that can be typed from the keyboard. Up to seven characters will be accepted, after the seventh they will be truncated. If less then 7 characters are entered, nulls will be inserted after the characters.

As an example, if you wanted to enter "%Q%L012" then type:

[ESC][ESC],[Q],[ESC][ESC],[L],[0],[1],[2],[RETURN]

The display will change the printer initilization code to the code that was just typed in. The display is all that has been changed. The new code has not been entered into the file for the printer codes, and won't be until the changes are saved to the data diskette.

DEGREE SYMBOL

The display will now be:

PRINTER CODES

PRINTER INIT: &Q&L012

In decimal: 27,81,27,76,48,49,50

DEGREE CHAR: ♥♥♥♥♥♥♥♥♥♥♥♥♥♥

In decimal: 0,0,0,0,0,0,0

0,0,0,0,0,0,0

DEG CHAR?■

If input for the degree symbol code is declined the program will display the printer menu without changing the degree symbol code.

Up to 14 characters are allowed for the degree code. The reason for so many spaces is that some printers do not have a degree symbol available. When this is the case a degree symbol can be specified with the use of bit image graphics if the printer has this capability. The following is the arrangement of the dots for a degree symbol in a 8x8 character matrix:

```
OO●●●OOO
O●OOO●OO
O●OOO●OO
OO●●●OOO
OOOOOOOO
OOOOOOOO
OOOOOOOO
OOOOOOOO
```

As an example, if the bit information was organized in a vertical column of dots with the least-significant bit at the top, the decimal code for the degree character would be:

0,6,9,9,9,6,0,0

If the printer command for 8 bytes of bit image graphics is "&S0008", then putting the character code with it, the following would need to be typed:

[ESC][ESC],[S],[0],[0],[0],[8],[CTRL][,],
[CTRL][F],[CTRL][I],[CTRL][I],[CTRL][I],
[CTRL][F],[CTRL][,],[CTRL][,],[RETURN]

After the degree symbol code has been entered or declined the program will return to the printer menu. The display will show any changes that have been made.

[1] SAVE [2] CHANGE [0] MENU

## PRINTER CODES

PRINTER INIT: &Q&L012

In decimal: 27,81,27,76,48,49,50

DEGREE CHAR: &S0008♥/▪▪▪/♥♥

In decimal: 27,83,48,48,48,56,0

6,9,9,9,6,0,0

If the printer codes look correct, save them to the data diskette by pressing the [1] key. If not, the codes can be re-entered.

## VIII. PROGRAM LIMITATIONS

### NAVIGATIONAL AREA

The AIR NAVIGATION/*RNAV* program is limited to the Western half of the Northern Hemisphere. This area includes the North and Central Americas. In this area all the latitude and longitude coordinates are positive.

The formulas used for the calculations theoretically will work for the entire globe. However, I haven't proven this in actual flying. For this reason the AIR NAVIGATION/*RNAV* program considers only the area that I have proven the math experiencially.

The area limitations shouldn't effect the usefulness of this program as aircraft that are capable of international travel will use inertial navigation systems, which do not need to rely on navaids. Additionally, by far the majority of flying by light aircraft is done in the North American Countries. It is these countries which maintain the extensive coverage of navaids which this program makes use.

### EQUATOR

The equation for the course does fail when traveling East or West along the equator. No provision is made in the program to correct for this error.

## IX. PROGRAM HISTORY

### THE AUTHOR

It is appropriate that I explain my interest in aeronautical navigation and share my aeronautical credentials. I am a Corporate pilot with 5000 hours flying experience. In addition I am an airplane and instrument flight instructor in single and multiengine airplanes, also an advanced and instrument ground instructor. I have given over 2000 hours of flight instruction and currently still giving lessons.

### THE PROGRAM

Sometime back, when I flew only for pleasure, it was fun to plan for a flight. The evening before the trip, charts would be spread out over the living room floor. With plotter and flight computer in hand the trip would be plotted, measured, and planned out. As my flying matured from pleasure to vocation the luxury of leisurely planning trips disappeared. If you too, are a corporate pilot, you know that many trips come on short notice. Passengers often want to know how far and how long the trip and need the information immediately if not sooner.

Using area navigation saves flying time and that means less fuel consumed and less cost. However, this also means spreading maps out (usually more than one) and drawing a line across them. Then each waypoint needs to be plotted and recorded.

Fortunately, Theopolis, our family ATARI 800, held the solution, and it has worked out great. The AIR NAVIGATION/*RNAV* program has enabled flight routes and waypoints to be planned quickly and accurately. Passengers have been impressed with the computer planned navigation. Employers appreciate being provided flight estimates quickly with resulting time and flight cost savings. Using the computer has been a tremendous assistance to me in performing my job with a high degree of professionalism.

An example of the flight form and printout that I use in the cockpit is given in the appendix.

## X. NAVIGATION THEORY AND FORMULAS

### INTRODUCTION

While this section has no bearing on using the AIR NAVIGATION/*RNAV* program, it is presented to answer any questions on how the program arrives at its navigational solutions. The original formulas are presented along with the formulas in terms of Atari functions.

### NAVIGATION THEORY

In navigation we are concerned with traveling from one point to another on the Earth's surface. To do this we picture the surface of the Earth on charts. A basic problem presents itself as the Earth is round, but the chart is flat. It is impossible to picture the surface of the Earth on a flat plane without some distortion.

The other problem in navigating is that the two points may be joined together by two different straight lines. The Rhumb Line is a straight line that intersects all the meridians (lines of longitude) at the same angle. It is the easiest to navigate, but the longest in distance. The Great Circle is the shortest distance between two points, however the course is constantly changing, as it crosses each meridian at a slightly different angle. Because of this constantly changing course it is impossible to accurately fly the route.

The method used in aeronautical charts to project the surface of the Earth onto a flat chart is the Lambert Conformal Conic Projection. The Lambert may be recognized by the meridians being straight lines converging at some point off the top of the chart, and the parallels (lines of latitude) are arcs of concentric, equi-distant circles. This is very apparent in the illustration of the chart's coverage on the front of the chart.

Because of the convergence of the meridians on the aeronautical charts, a straight line will intersect each meridian at a slightly different angle. In fact, the straight line very closely approximates a Great Circle, so close that for all practical purposes they are the same. Radio bearings may be plotted directly on the chart without correction, as radio signals travel between two points in a straight line along a Great Circle.

## NAVIGATION ACCURACY

The disadvantage to the Lambert chart is that the course angle will vary along the route. Normally the course angle is measured at a meridian located midcourse which will give an average course. For all practical purposes this is more than sufficient, as the distances that can be traveled in a light aircraft are short enough that the error remains insignificant.

In the AIR NAVIGATION/*RNAV* program the course angle is calculated at the meridian that intersects the departure fix. The advantage to this is the calculation time is half what it would be to calculate the average course angle. The disadvantage is the course angle at the destination fix will have all the error instead of being averaged. The amount of error is still small enough for the leg lengths that are traveled.

Because of these inherent navigation problems, sometimes when the reverse route is calculated there will be small differences in the course, distance, and waypoints. To bring the error possibilites into perspective, the sample flight's longest leg between fixes was between TYS airport and COWAN intersection and it was 105 NM. The only discrepancy was in the HCH waypoint which occurred between the two fixes, and then the radial differed by only 0.1 NM. Discrepancies can also occur because of rounding off the last digit.

## DISTANCE

The Great Circle distance between fixes is calculated by the following formulas:

$$d=\cos^{-1}[\sin(LAT)\sin(LAT')+\cos(LAT)\cos(LAT')\cos(LNG-LNG')]$$

$$(\text{Distance in NM})=60d$$

Where: LAT' and LNG' are the coordinates of the "from" fix.
LAT and LNG are the coordinates of the "to" fix.

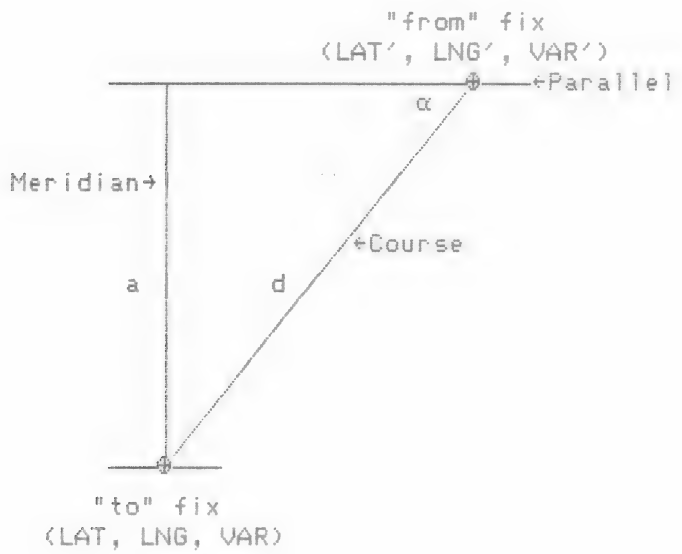
Using Atari functions the formula for d is:

$$d=90-\tan^{-1}[X/(1-X^2)^2]$$
$$X=[\sin(LAT)\sin(LAT')+\cos(LAT)\cos(LAT')\cos(LNG-LNG')]$$

COURSE

The course is derived by finding the angle "α" between the parallel passing through the "from" fix and the Course. The angle "α" is then corrected for East/West direction of travel.

A diagram illustrating the relationships is given below with the formulas:




$a=COS^{-1}(Y)$ Using Atari functions: $a=90-TAN^{-1}[Y/(1-Y^2)^2]$
$Y=[SIN(LAT)SIN(LAT')+COS(LAT)COS(LAT')]$

$d=COS^{-1}(X)$ Using Atari functions: $d=90-TAN^{-1}[X/(1-X^2)^2]$
$X=[SIN(LAT)SIN(LAT')+COS(LAT)COS(LAT')COS(LNG-LNG')]$

$\alpha=SIN^{-1}(A)$ $A=SIN(a)/SIN(d)$
Using Atari functions: $\alpha=TAN^{-1}[A/(1-A^2)^2][SGN(LAT-LAT')]$

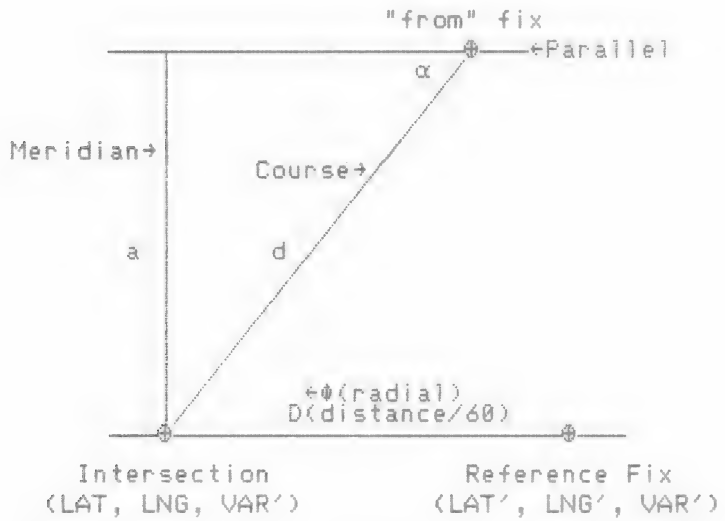
If (LNG′-LNG)<0 then TC=270+α (Westerly direction of travel.)
If (LNG′-LNG)≥0 then TC=90-α (Easterly direction of travel.)

MC=TC+VAR′, and if VAR≠VAR′ then MC=TC+VAR′/TC+VAR

## INTERSECTIONS

Intersections are always defined by the radial (magnetic bearing) and distance from a known fix (reference navaid). The program uses this information along with the coordinates of the reference fix to derive the coordinates of the intersection. These coordinates are then used the same as the coordinates of any other fix.

A diagram illustrating the relationships and the formulas is given below:




$$LAT=LAT'+SIN^{-1}[(SIN\ D)(COS\ \Phi)]$$

$$LNG=LNG'-SIN^{-1}[[(SIN\ D)(COS\ \Phi)]/[COS[(LAT+LAT')/2]]$$

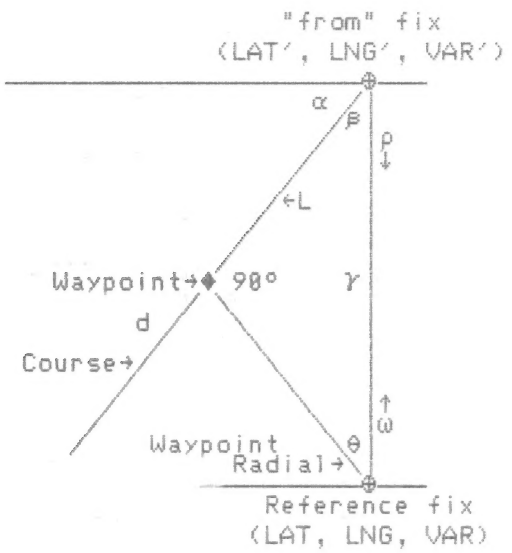
The formulas using Atari functions:

$$LAT=LAT'+TAN^{-1}[X/(1-X^2)^2]$$
$$X=(SIN\ D)(COS\ \Phi)$$

$$LNG=LNG'-TAN^{-1}[Y/(1-Y^2)^2]$$
$$Y=X/COS[(LAT+LAT')/2]$$

## WAYPOINTS

Waypoints are calculated by deriving the bearing and distance of the waypoint from the reference navaid along the radial that is perpendicular to the course. This will form a spherical right triangle between the waypoint, reference navaid, and the "from" fix:




The bearing ($\rho$) and distance angle ($\gamma$) from the "from" fix to the reference fix is calculated first. The angle, $\gamma$, is calculated with the same formula as used to find the course distance angle (d), and $\rho$ is calculated the same way as the true course. The bearing ($\omega$) from the reference fix to the "from" fix and is the reciprocal of $\rho$, $\omega=\rho\pm180$. The angle, $\beta$, is the difference between the bearing ($\rho$) and the true course. This angle is expressed as:

$$-180° \leq \beta \leq 180°$$

If $\beta > |90°|$ then the way point will not be usable because it will occur the other side of the "from" fix.

The distance (L) between the "from" fix and the waypoint is calculated with the following formula:

$$L=60[SIN^{-1}[SIN(|\theta|)SIN(\gamma)]] \qquad \theta=90-\beta$$

Using the Atari functions the formula becomes:

$$L=60[TAN^{-1}[X/(1-X^2)^2]]$$
$$X=SIN(|\theta|)SIN(\gamma)$$

The waypoint radial and distance are calculated with the following formulas:

$$\text{Waypoint radial} = \omega+SGN(\beta)(\theta)+VAR$$

$$\text{Waypoint distance} = 60[SIN^{-1}[SIN(|\beta|)SIN(\gamma)]$$

Using Atari functions:

$$\text{Waypoint distance} = 60[TAN^{-1}[Y/(1-Y^2)^2]$$
$$Y=SIN(|\beta|)SIN(\gamma)]$$

## TERMINAL WAYPOINTS

The terminal waypoints are calculated by letting the reference navaid be the "from" fix and the terminal airport be the "to" fix. The same formulas used to find the true course and distance are used. The reference navaid's magnetic variation is added to the bearing from the reference fix to the terminal airport to obtain the proper radial. The reference navaid's magnetic variation is also used to obtain the magnetic course from the departure airport or to the destination airport as the case may be.

## XI. DISKETTE BACKUP PROCEDURES

A backup copy of the data diskette you are currently using should be made in case anything goes wrong with it.

The steps for diskette backup are:

1. Insert the DOS II Master diskette into your disk drive and turn the computer to ON.

   OR:

   If the AIRNAVIGATION/*RNAV* program has been loaded into your computer, then exit the program from the main menu with the [ESC] key. Insert the program diskette into your disk drive.

2. Enter the word "DOS" after the READY prompt is displayed.

3. Select item I (format disk).

4. Select Drive 1 as the drive to format.

5. Insert a blank diskette and type Y.

6. After the formatting is complete, select item J (Duplicate Disk).

7. Type "1,1" for the source and destination drives.

8. Insert the source diskette (making sure its write-protect notch is covered with tape) and press the [RETURN] key.

9. When the drive stops, insert the blank diskette and press the [RETURN] key.

10. Repeat the last two steps until the source diskette is fully copied and the following message appears: SELECT ITEM OR RETURN FOR MENU.

APPENDIX: SAMPLE FLIGHT FORM

**FLIGHT PLANNING**

DATE 11-21-83

DEPARTMENT OF TRANSPORTATION – FEDERAL AVIATION ADMINISTRATION
FLIGHT PLAN

| 1. TYPE | 2. AIRCRAFT IDENTIFICATION | 3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT | 4. TRUE AIRSPEED | 5. DEPARTURE POINT | 6. DEPARTURE TIME PROPOSED (Z) | 6. DEPARTURE TIME ACTUAL (Z) | 7. CRUISING ALTITUDE |
|---|---|---|---|---|---|---|---|
| VFR / IFR / DVFR | 38507 | BE36/R | 160 KTS | TYS | 1930 | | 8000 |

8. ROUTE OF FLIGHT

D→ HCH 153019 D→ COWAN
VSHN RQZ VSH MSL D→

| 9. DESTINATION (Name of airport and city) | 10. EST. TIME ENROUTE HOURS | 10. EST. TIME ENROUTE MINUTES | 11. REMARKS |
|---|---|---|---|
| MSL | 1 | 20 | |

| 12. FUEL ON BOARD HOURS | 12. FUEL ON BOARD MINUTES | 13. ALTERNATE AIRPORT (S) | 14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE | 15. NUMBER ABOARD |
|---|---|---|---|---|
| 4 | 00 | | ROBERT A. TIMS | 4 |

16. COLOR OF AIRCRAFT: BEIGE

—WINDS ALOFT

9000'
TYS - 3215
CHA - 3415
MSL - 0210

NOTES AND CLEARANCES:

TYS TO MSL
192 NM

TYS AIRPORT * TYS 221.9° 7.3 NM
MC=245°/243° DIST=44 NM REM=148 NM
HCH WAYPOINT 153.1° 19.3 NM
MC=243° DIST=61 NM REM=87 NM
COWAN INTERSECTION * CHA 277.0° 38.0 NM
MC=246°/245° DIST=38 NM REM=49 NM
RQZ NAVAID
MC=261°/262° DIST=43 NM REM=6 NM
MSL NAVAID
MC=290° DIST=6 NM
MSL AIRPORT